EBAF Update

N. G. Loeb[1], D. R. Doelling[1], J. C. Wilkins[2], P. E. Mlynczak[2], S. Kato[1], F. G. Rose[2]

[1]NASA Langley Research Center, Hampton, VA

[2]Science Systems and Support Services, Inc. (SSAI), Hampton, VA

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Max Planck Institute, Hamburg, Germany

Introduction

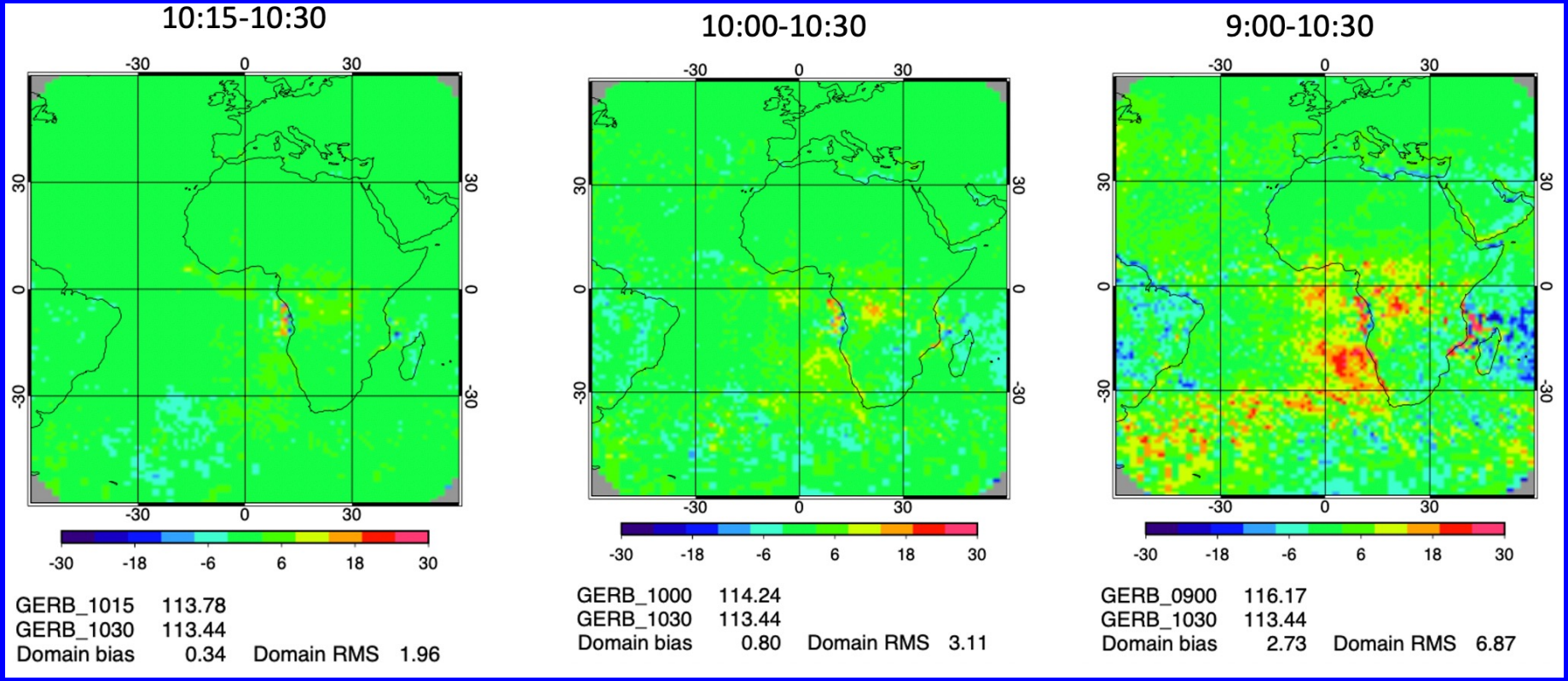
- Current version of EBAF (Ed4.1) uses Terra-Only for 03/2000-06/2002 and Terra+Aqua for 07/2002 onwards.
- An update to EBAF prior to Edition 5 is necessary in order to account for:

  1) Changes in Terra and Aqua MLTs.
  2) Artifacts and discontinuities in GEO cloud retrievals, which impact EBAF surface fluxes.
  3) Discontinuities with time in GEOS 5.4.1 meteorological inputs, which impact EBAF surface fluxes.

- New version will be called EBAF Ed4.2.
- **Timeline:** Anticipate public release of full (TOA & SFC) EBAF Ed4.2 during fall 2022.

Impact of a Change in MLT on SW Reflected Solar Radiation

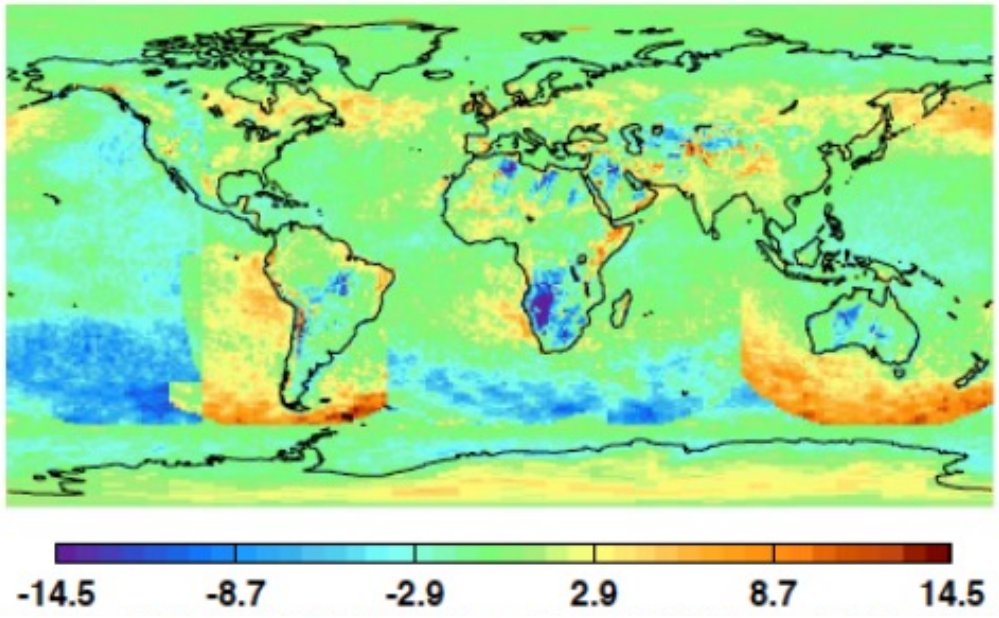
- Compare GERB SW TOA flux at 10:15 am, 10:00 am and 9:00 am vs 10:30 am
- Normalize each observation to a common 10:30 am solar geometry



- To avoid discontinuity in CERES record, MLT must remain within 15 min of 10:30 am for Terra and 1:35 pm for Aqua.
- **EBAF will be reprocessed to ensure an MLT < 15 min by transitioning from Terra+Aqua to NOAA-20.**

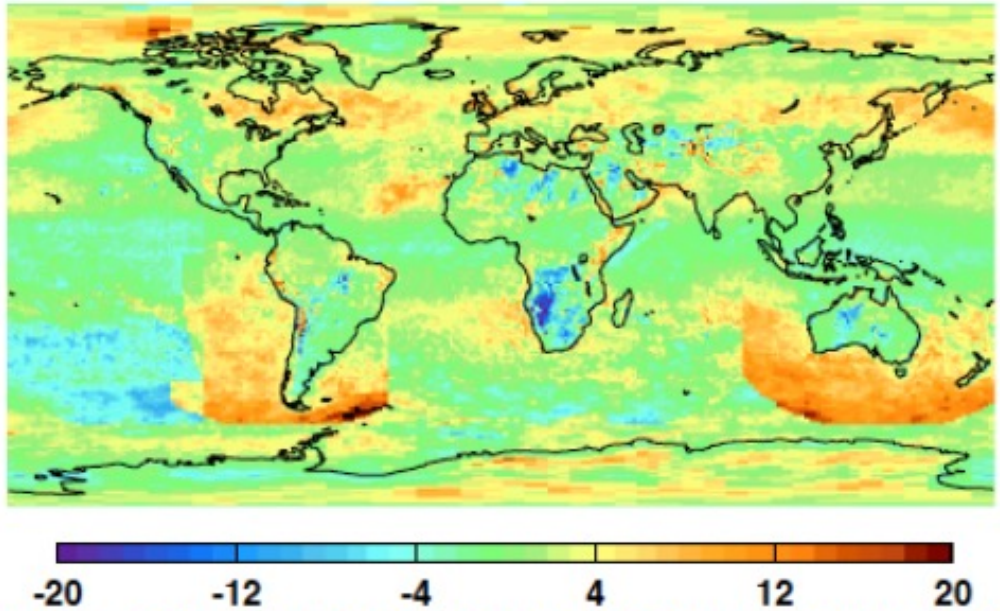
Downward LW Flux at Surface: Sensitivity to GEO Cloud Retrieval Artifacts (Computed DLW MODIS-Only minus Computed DLW MODIS+GEO)

Ter+Aqu_MODIS minus SYN1deg_Ter+Aqu+GEO (July 2019)



Difference (Wm^{-2})

Terra+Aqua_MODIS minus EBAF Ed4.1 (July 2019)



Difference (Wm^{-2})

- The largest effects of GEO artifacts on surface downward longwave flux come from nighttime cloud optical thickness (and depend on GEO).

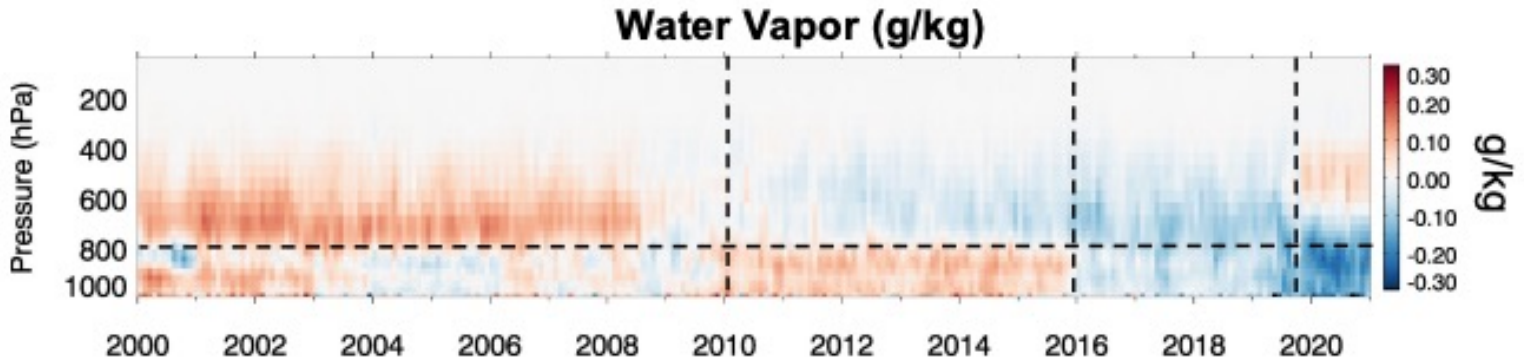
Seiji Kato (Fall 2020 CERES meeting)

Discontinuities in GEOS 5.4.1 Water Vapor Profiles

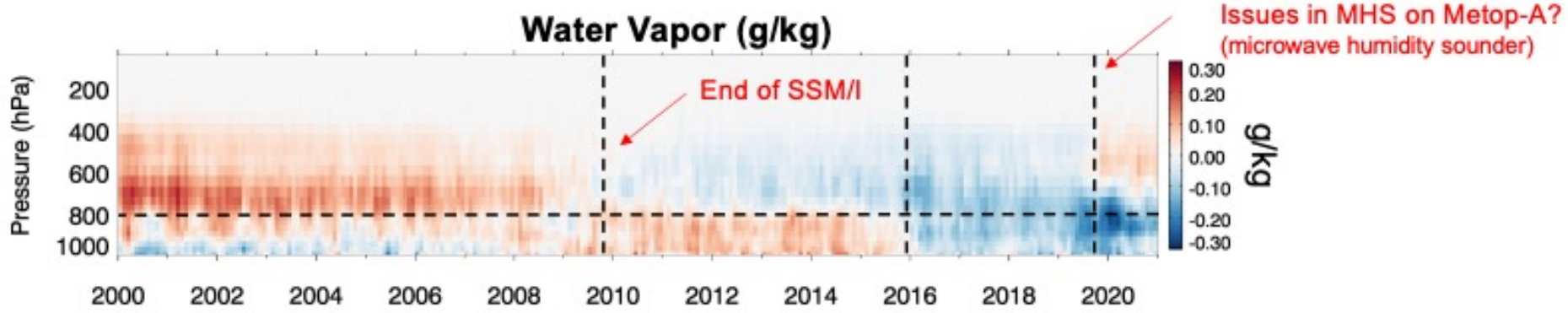
60S-60N Land+Ocean

Area weighted; climatology is obtained using 2003-2020

[G-5.4.1 WV Anomalies] – [MERRA-2 WV Anomalies]



[G-5.4.1 WV Anomalies] – [ERA-5 WV Anomalies]



- The differences between G541 and ERA5 are similar to those between G541 and MERRA-2.
- This implies that the differences are mainly driven by G541 problems.
- The discontinuities in G541 might be related to input observing data changes.

Seung-Hee Ham (Spring 2021 CERES meeting)

Planned Changes in EBAF Processing

1) **Transition to NOAA-20:**

Note: Climatology of Terra-Only and NOAA20-Only will be anchored to Terra+Aqua climatology using overlapping periods.

2) **EBAF-Surface fluxes will be processed with MODIS/VIIRS imager cloud retrievals (no GEO).**

3) **EBAF-Surface fluxes will be re-calculated using MERRA-2 meteorological inputs.**

- MODIS/VIIRS imager cloud properties will not be reprocessed (based upon GEOS 5.4.1)

TOA Flux Changes

1) Diurnal correction bug fix near international dateline
2) Climatological adjustment of TOA fluxes during Terra-only time period using Terra+Aqua climatology
3) Compiler differences (P6 vs x86)
4) Sampling: Recovery of some of the missing GEO data in Ed4.1.

CERES EBAF Ed4.0 Empirical Diurnal Corrections

- Use daily SYN1deg & SSF1deg files for 07/2002 – 06/2015 to compute climatological monthly mean ratios of SYN1deg-to-SSF1deg sorted by:

  1) Month (1-12)

  2) Surface Type: Open ocean (No snow), Desert, Other.

  3) Diurnal Asymmetry Ratio (DAR):

$$DAR = \{[F^{SW}(morn) - F^{SW}(aft)]/12\} / F^{SW}(24h)$$

- Develop diurnal corrections for Terra SSF1deg, Aqua SSF1deg, and Terra-Aqua SSF1deg.

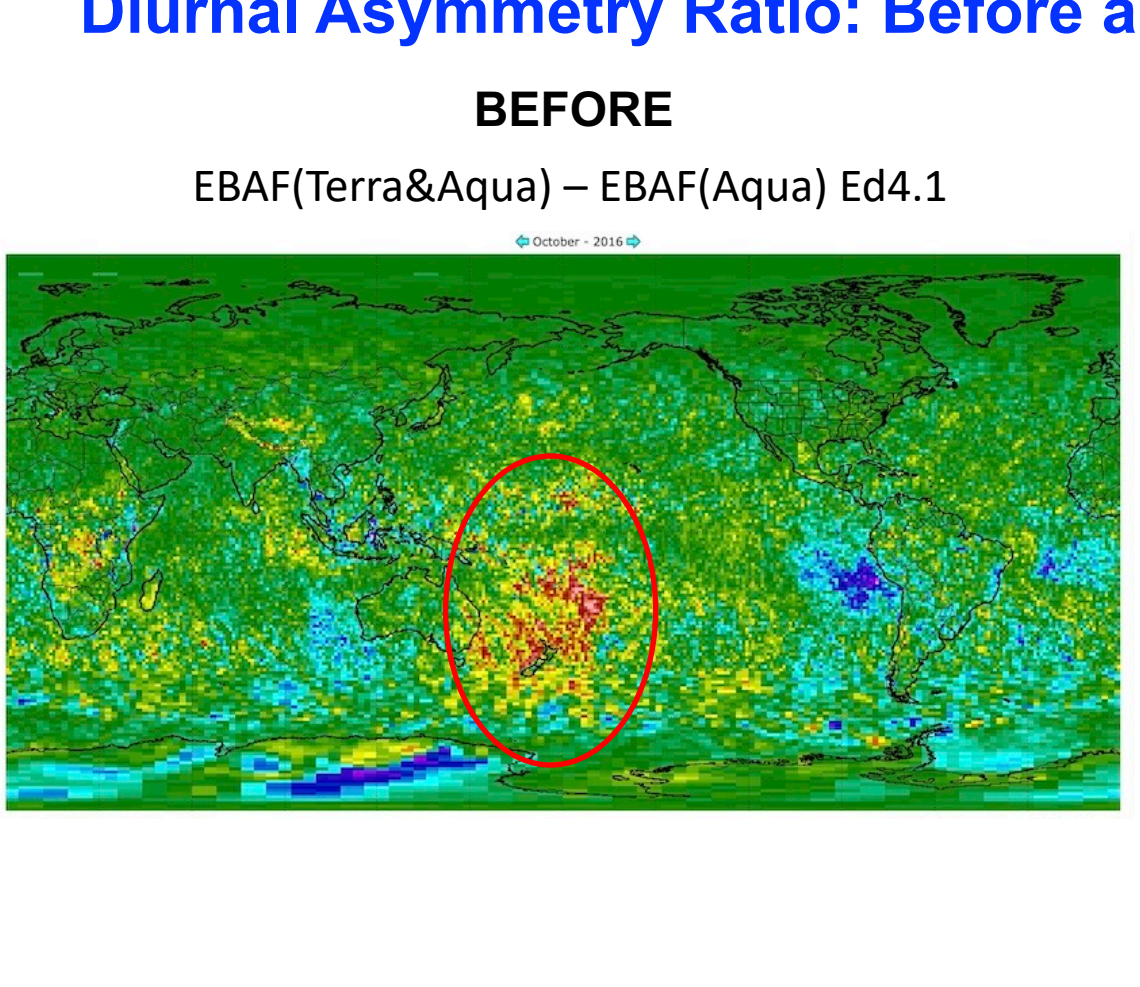
Application:

- Convert daily mean SSF1deg fluxes to diurnally corrected values (“SYN1deg-Like”).
- Average diurnally corrected SSF1deg fluxes to monthly means.

Diurnal Asymmetry Ratio: Before and After Correction (October 2016)

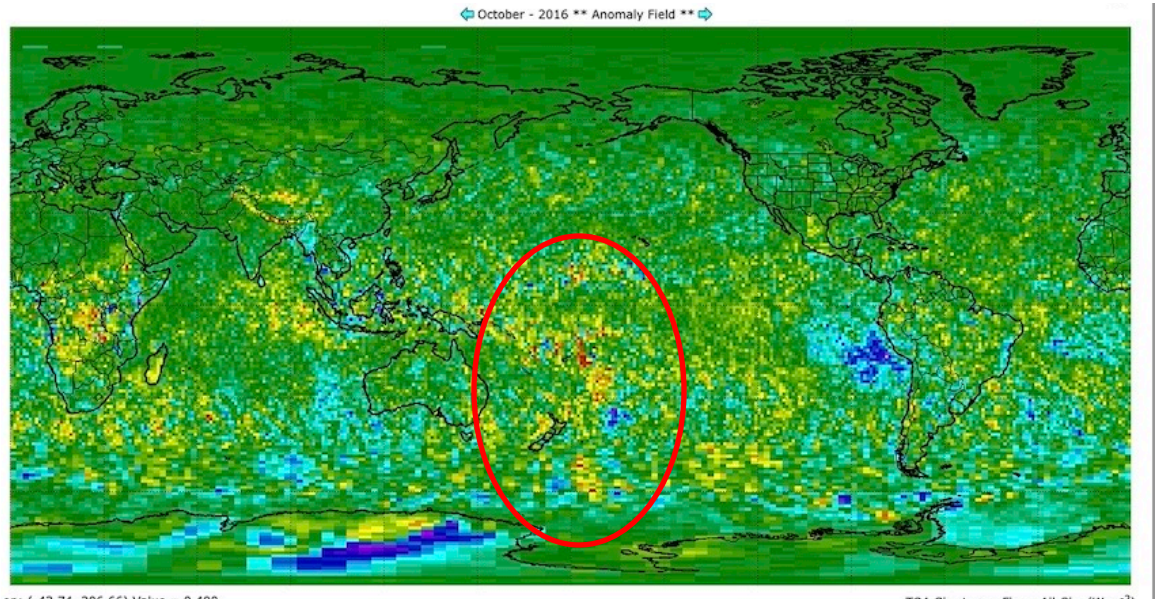
BEFORE

EBAF(Terra&Aqua) – EBAF(Aqua) Ed4.1

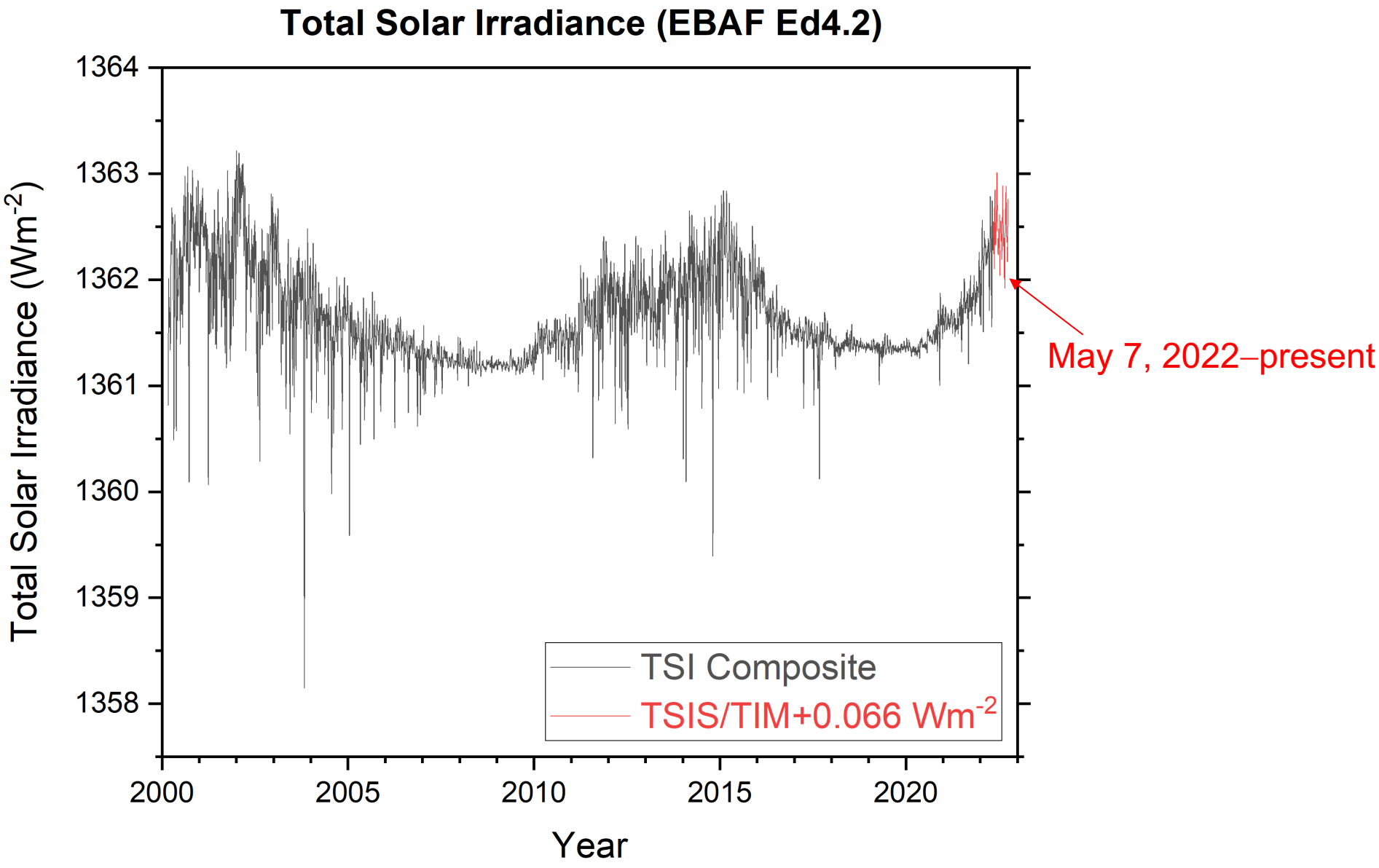


AFTER

EBAF(Terra&Aqua) – EBAF(Aqua) DAR fix



- Problem was related to the way DAR was calculated (GMT vs local time)
- Also found there was a day of hourly GEO data missing over Him-8 domain (90-180E)



- TSI Composite created by G. Kopp using methodology of Dudok de Wit et al. (2017).
- TSIS/TIM solar irradiance increased by 0.066 Wm^{-2} to place on same scale as TSI Composite.

Terra-Only & NOAA20-Only Climatological Adjustment

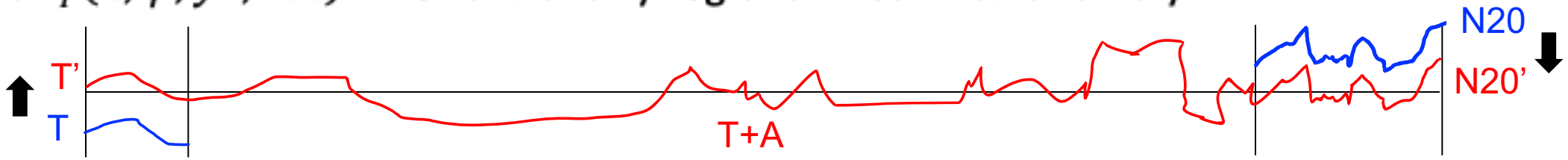
- **Terra-Only**: Use 5-year overlap with Terra+Aqua (07/2002-06/2007) to anchor Terra-Only period (03/2000-06/2002) to Terra+Aqua.
- **NOAA20-Only**: Use 4-year overlap with Terra+Aqua (07/2018-06/2022) to anchor NOAA20-Only period (07/2022-onwards) to Terra+Aqua.

$$F'_T(\lambda,\phi;yr,mn) = F_T(\lambda,\phi;yr,mn) + \{\bar{F}^O_{TA}(\lambda,\phi;mn) - \bar{F}^O_T(\lambda,\phi;mn)\}$$

$$= F_T(\lambda,\phi;yr,mn) + \bar{\Delta}^O(\lambda,\phi;mn)$$

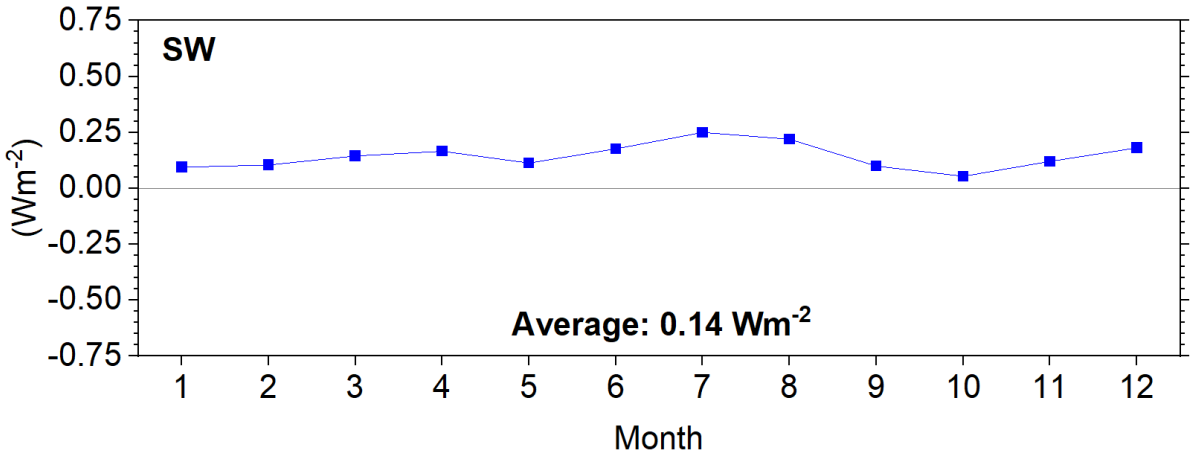
By definition: $\delta F'_T(\lambda,\phi;yr,mn) = \delta F_T(\lambda,\phi;yr,mn)$

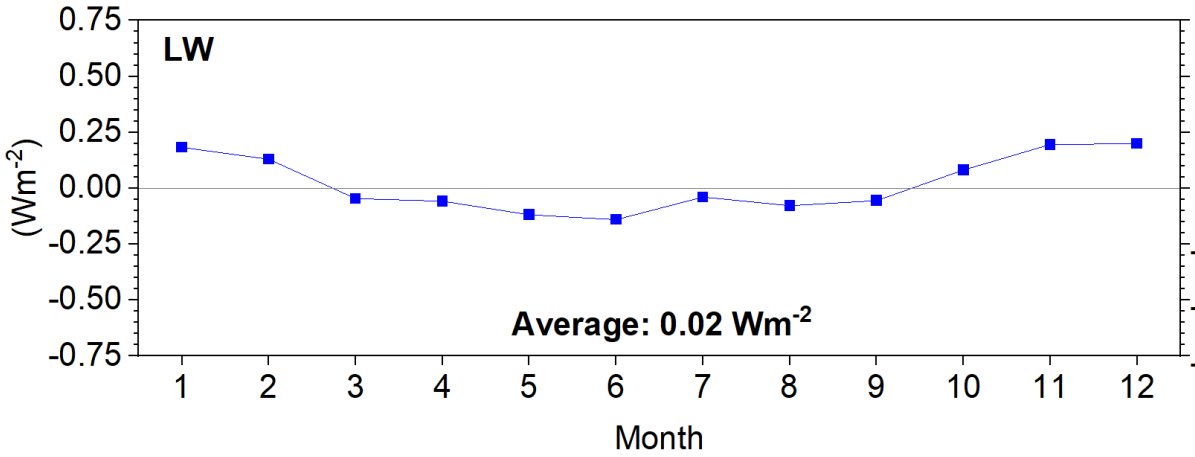
$F_T(\lambda,\phi;yr,mn)$ = Terra monthly regional mean flux
$\bar{F}^O_T(\lambda,\phi;mn)$ = Terra climatological monthly regional mean flux for overlap period
$\bar{F}^O_{TA}(\lambda,\phi;mn)$ = Terra+Aqua climatological monthly regional mean flux for overlap period
$\delta F_T(\lambda,\phi;yr,mn)$ = Terra monthly regional mean flux anomaly



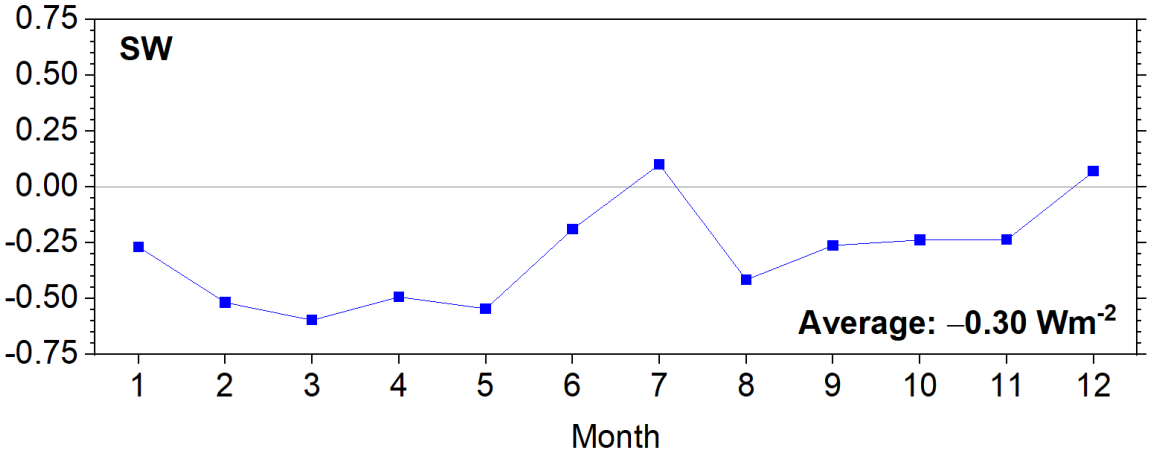
Terra and NOAA-20 Global Mean Climatological Adjustments

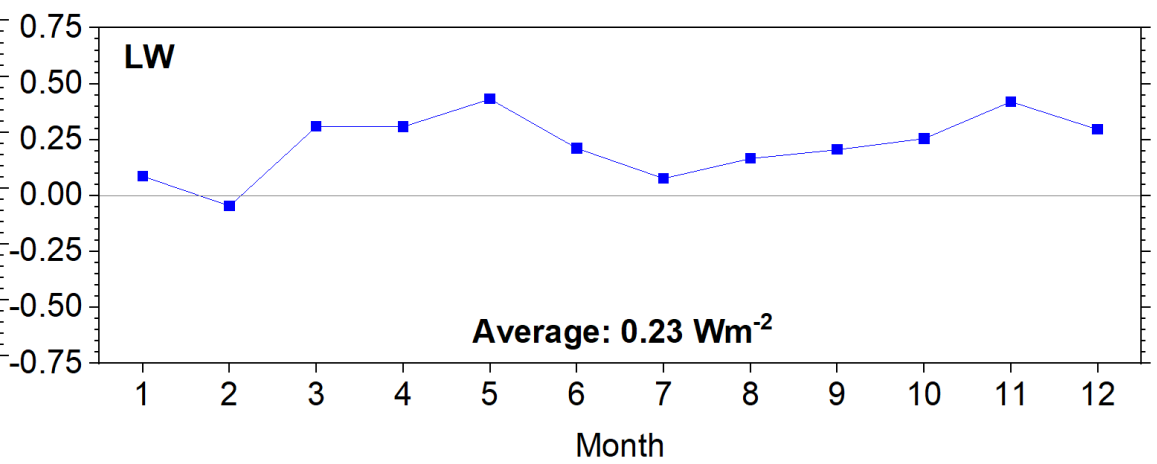
Terra





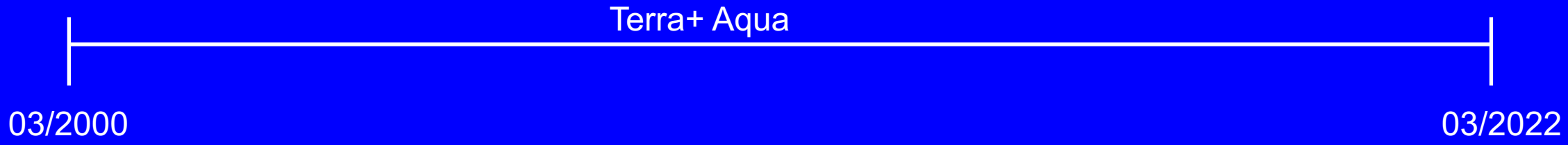
NOAA-20

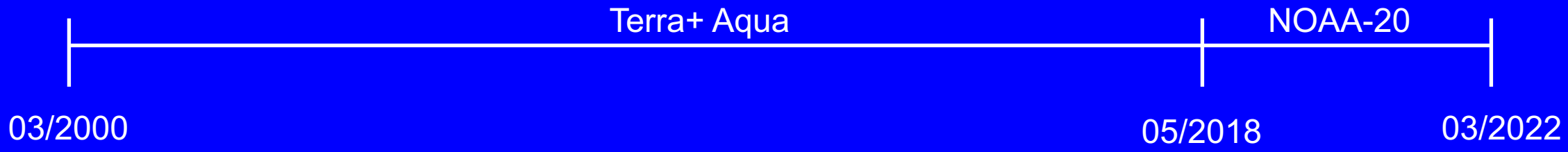




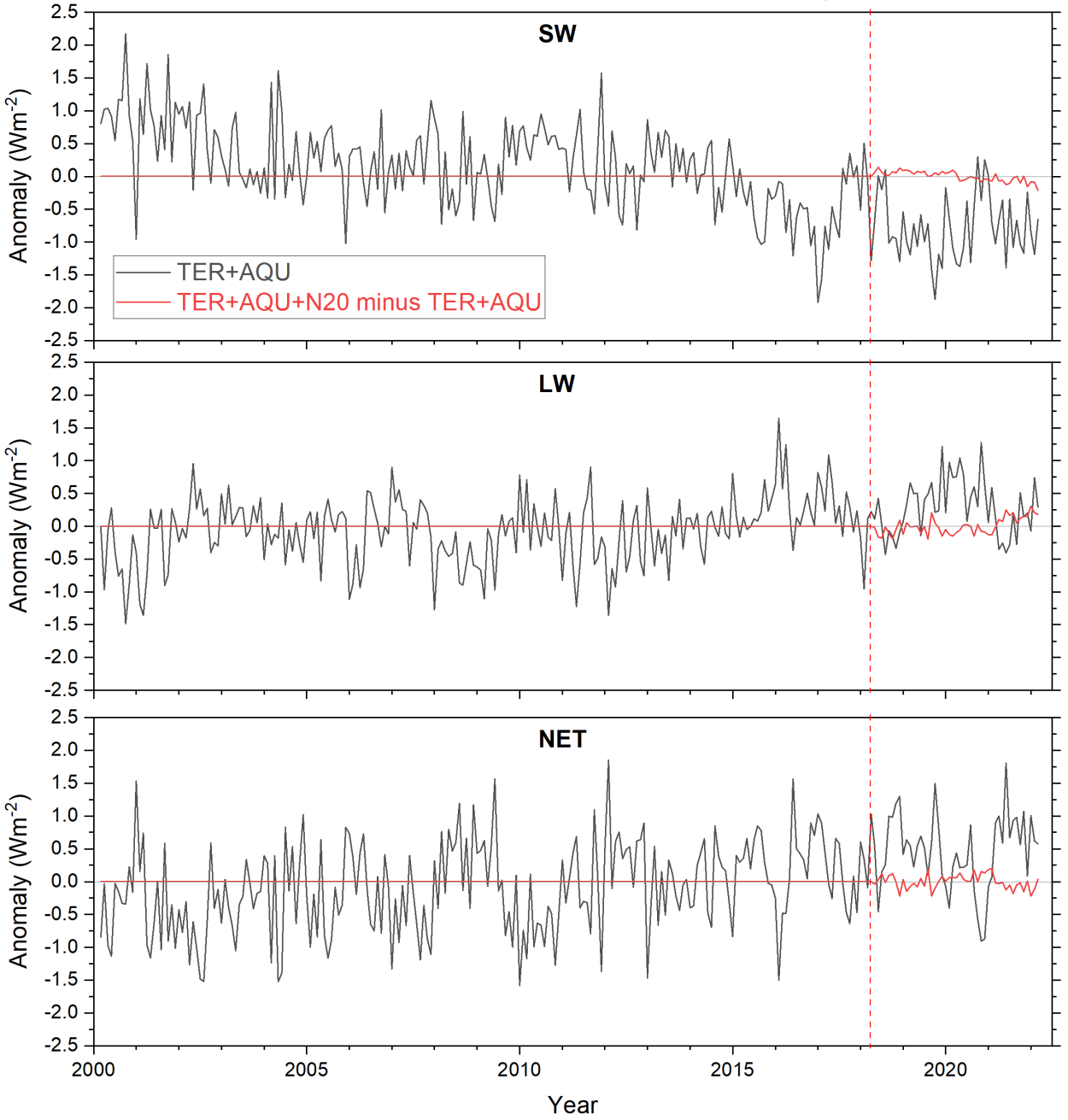
Terra+Aqua to NOAA-20 Transition: TOA Flux Sensitivity Analysis

- Assess anomaly and trend uncertainty in transitioning from TER+AQU to N20.
- Assume transition to N20 occurs in 05/2018 instead of 04/2022 and compare N20 vs TER+AQU anomalies for 05/2018 to 03/2022.



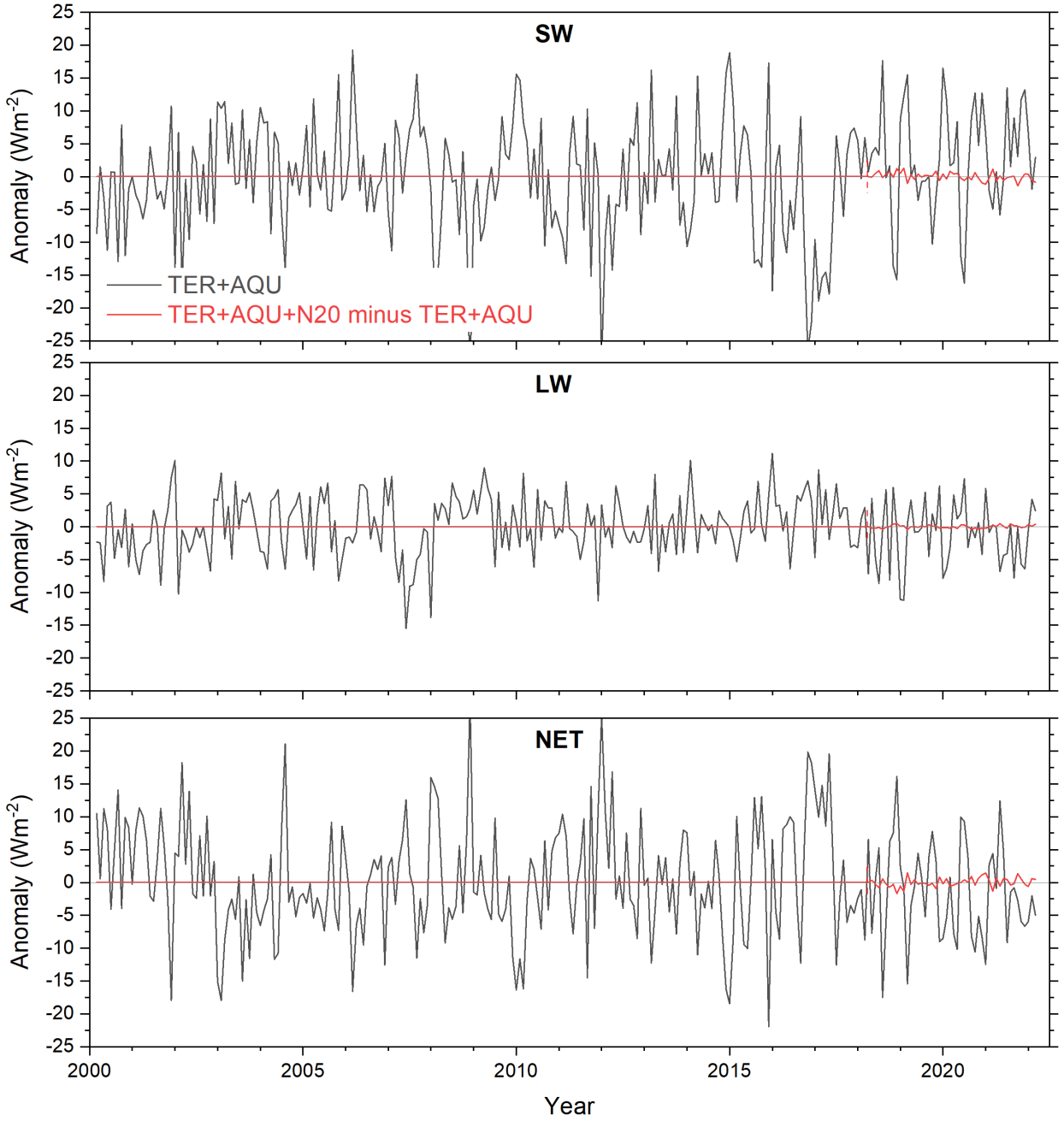


Global TOA Flux Anomaly & Trend Sensitivity Analysis (03/2000-03/2022)

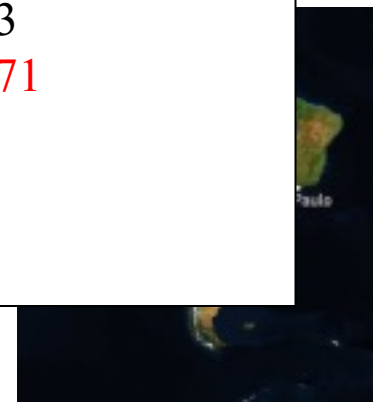


Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (03/2018-03/2022)
–0.73 0.003	0.49 0.078
0.27 0.004	0.43 0.13
0.44 –0.0008	0.57 0.11

Peruvian Stratus Region TOA Flux Anomaly & Trend Sensitivity Analysis (03/2000-03/2022; 15S-25S, 280-290)

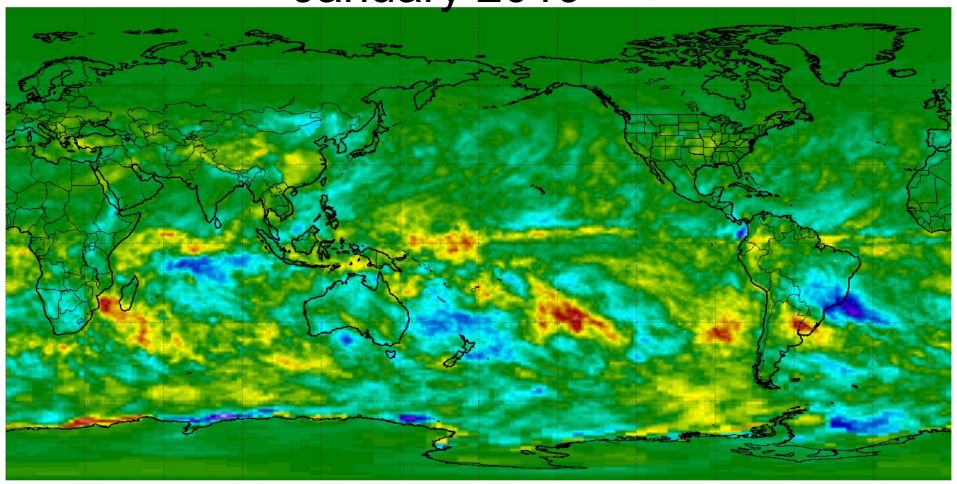


Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (05/2018-03/2022)
0.60 0.01	8.2 0.63
0.13 0.002	4.8 0.24
–0.76 –0.01	7.3 0.71

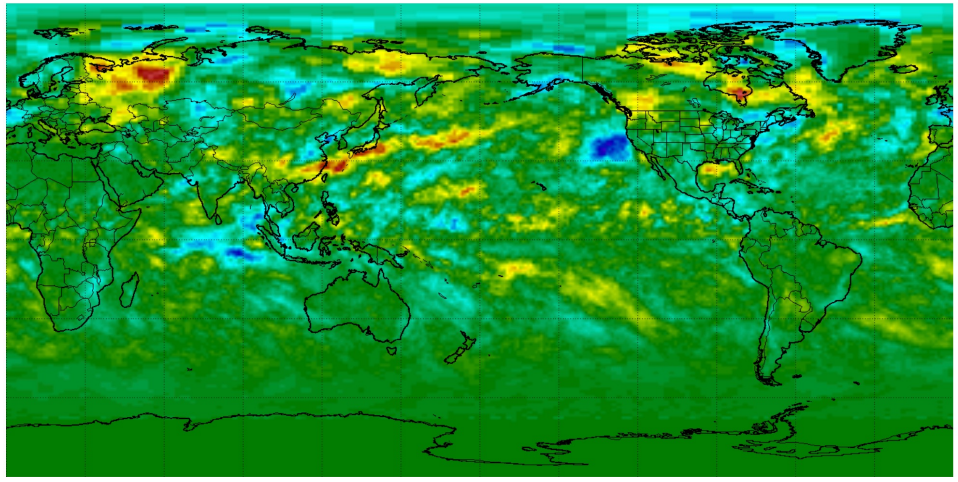


SW TOA Flux Anomaly (TER+AQU)

January 2019



July 2019



(Wm^{-2})

-75

-50

-25

0

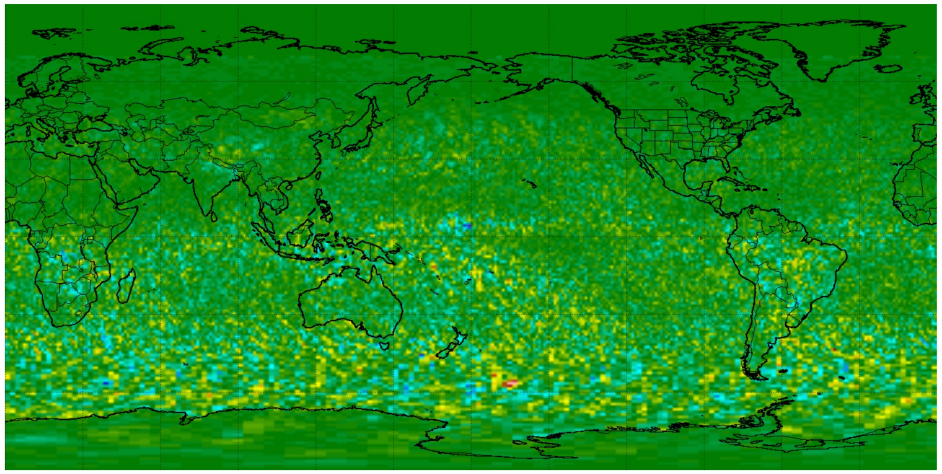
25

50

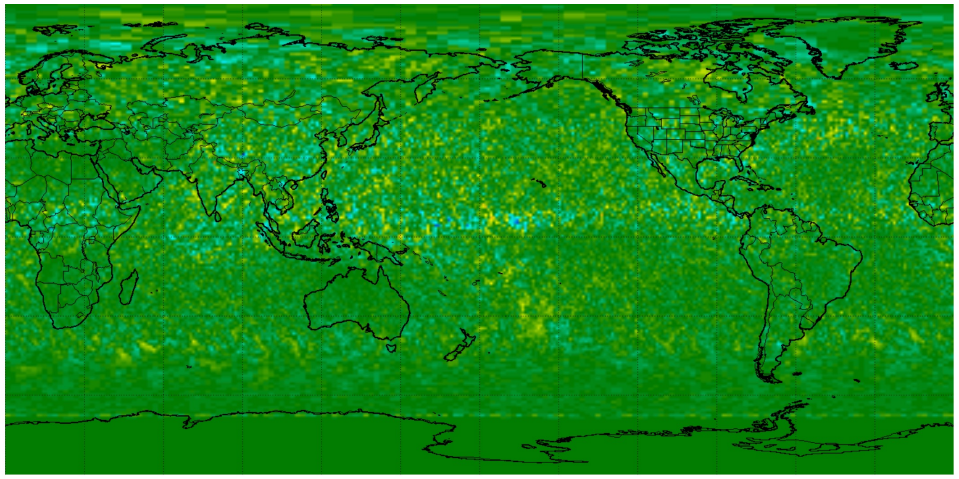
75

SW TOA Flux Anomaly DIFF (N20 Minus TER+AQU)

January 2019



July 2019



(Wm^{-2})

-20

-13.33

-6.67

0

6.67

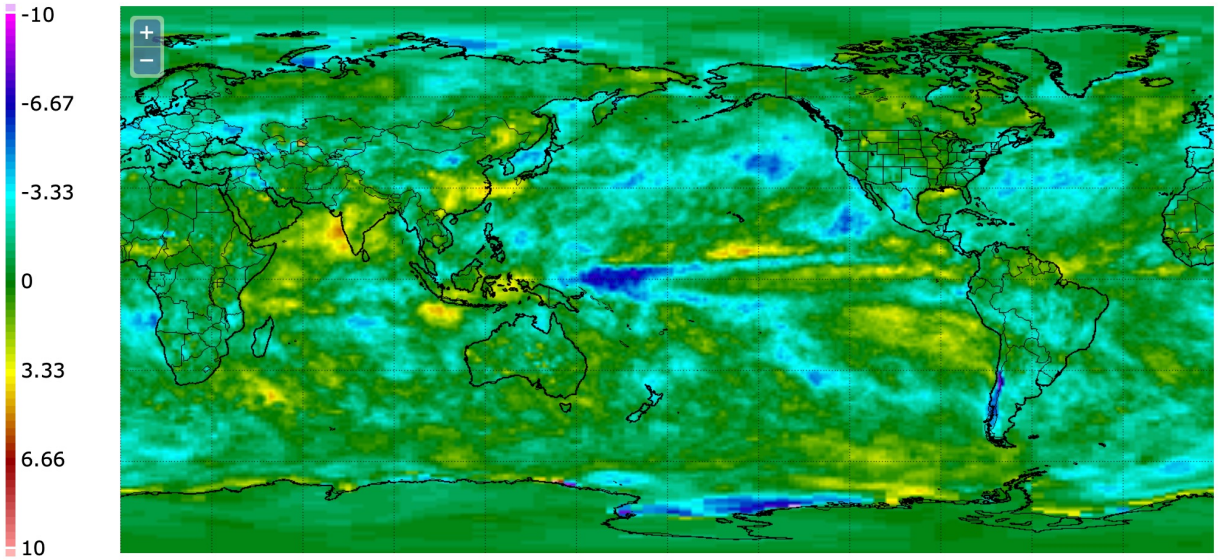
13.34

20

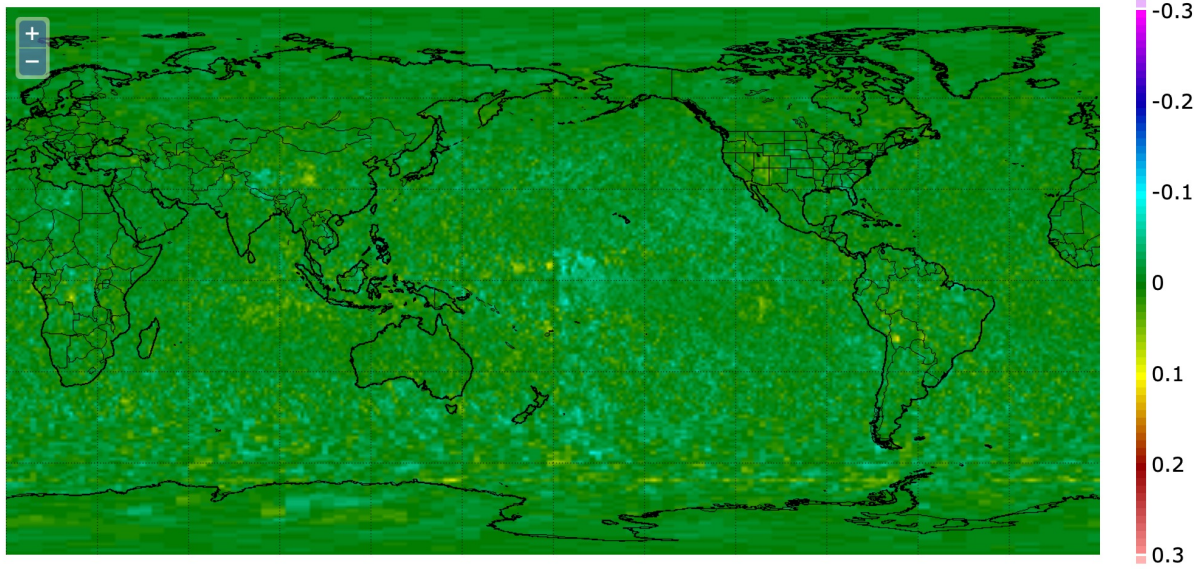
SW TOA Flux Trend (03/2000-03/2022)

(Wm^{-2} dec^{-1})

TER+AQU



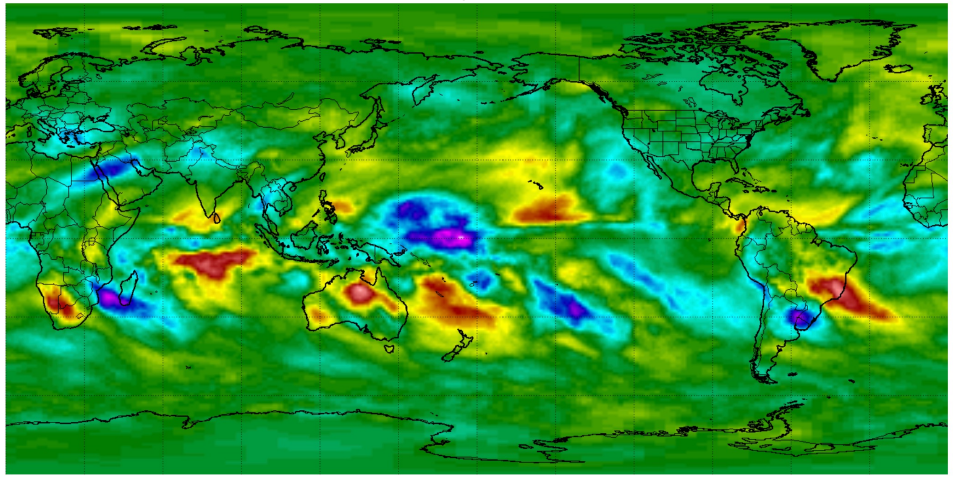
TER+AQU+N20 minus TER+AQU



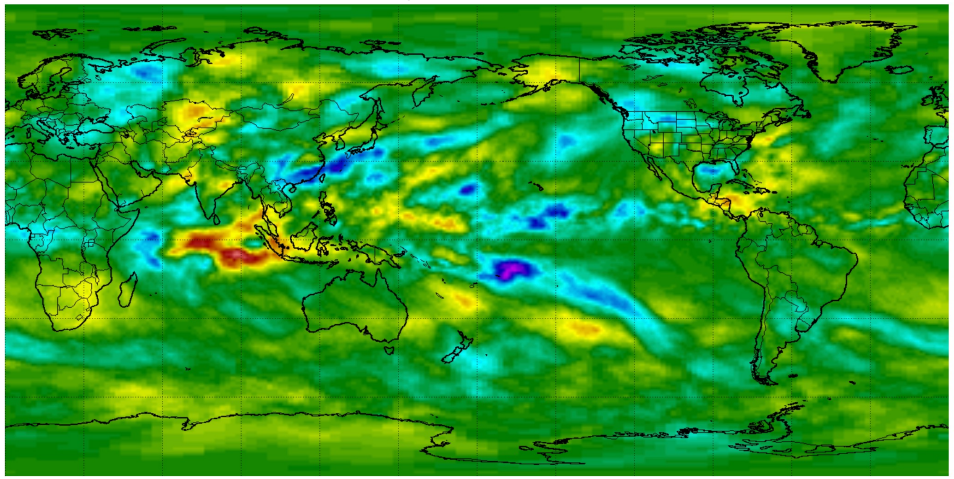
(Wm^{-2} dec^{-1})

LW TOA Flux Anomaly (TER+AQU)

January 2019



July 2019



(Wm^{-2})

-42

-28

-14

0

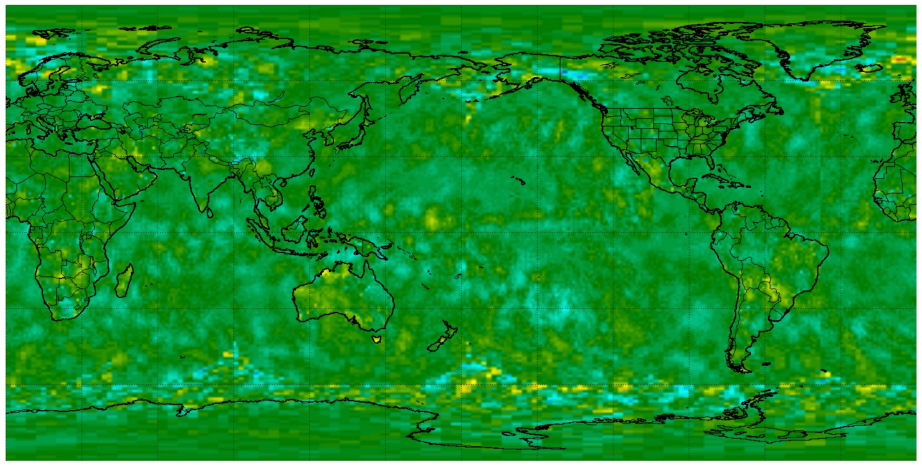
14

28

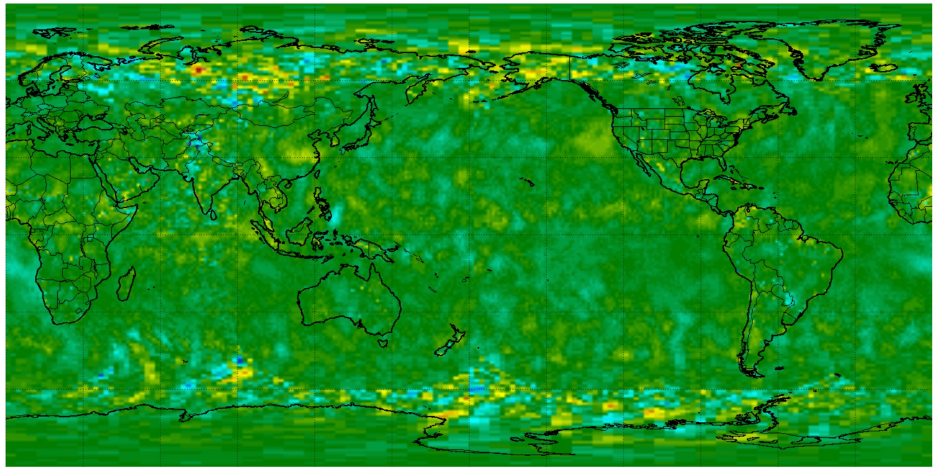
42

LW TOA Flux Anomaly DIFF (N20 Minus TER+AQU)

January 2019



July 2019



(Wm^{-2})

-5

-3.33

-1.67

0

1.67

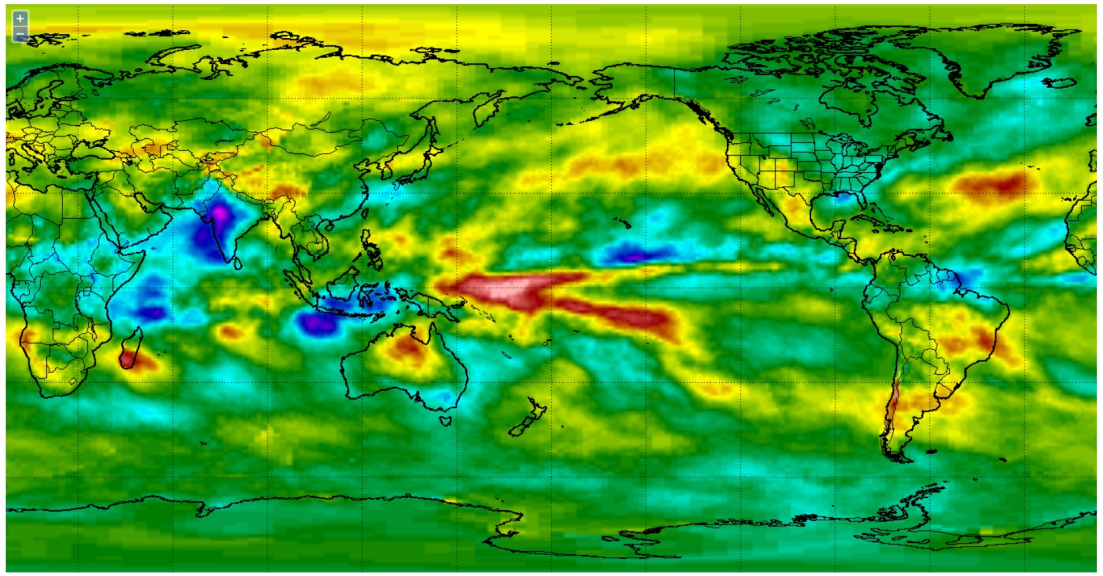
3.34

5

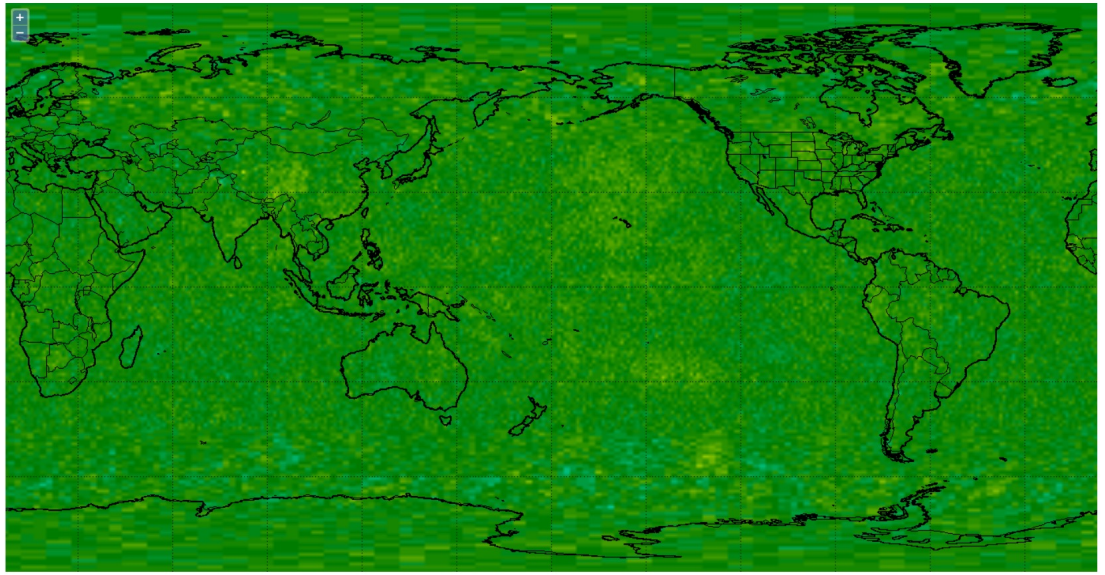
LW TOA Flux Trend (03/2000-03/2022)

(Wm^{-2} dec^{-1})

TER+AQU

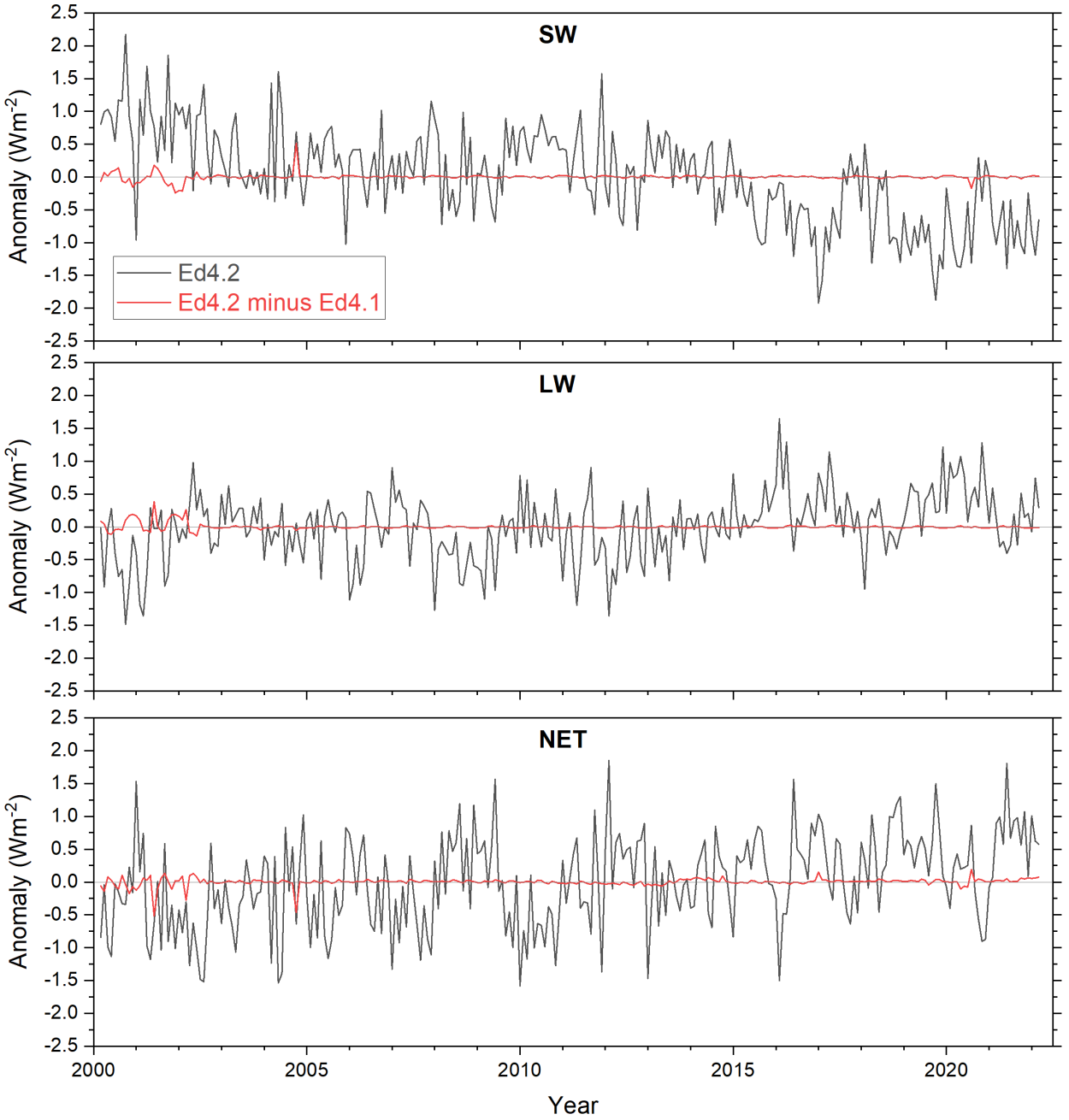


TER+AQU+N20 minus TER+AQU



(Wm^{-2} dec^{-1})

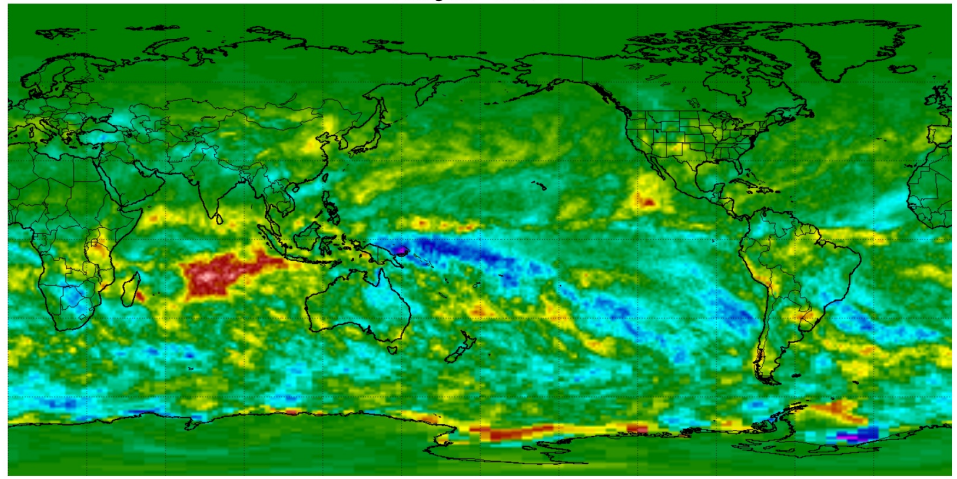
Global TOA Flux Anomaly Ed4.2 vs Ed4.1 (03/2000-03/2022)



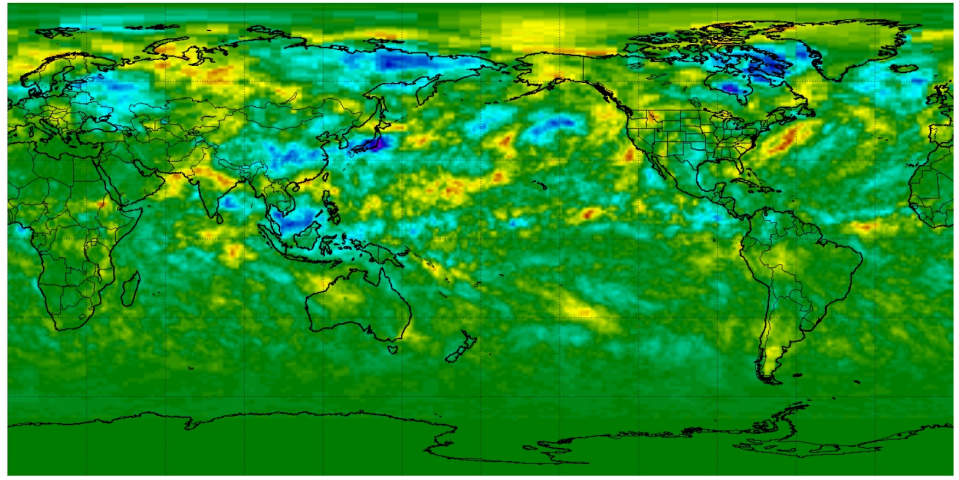
Trends (Wm^{-2} dec^{-1}) (03/2000-03/2022)	Stdev(Anomaly) (Wm^{-2}) (03/2000-03/2022)
–0.73 0.002	0.72 0.05
0.26 –0.01	0.51 0.05
0.44 0.02	0.70 0.06

SW TOA Flux Anomaly (Ed4.2)

January 2001



July 2001

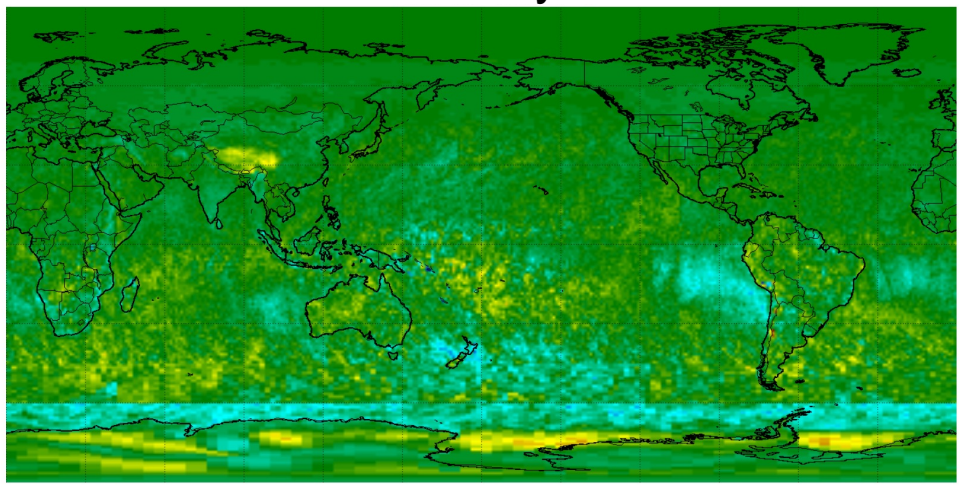


(Wm^{-2})

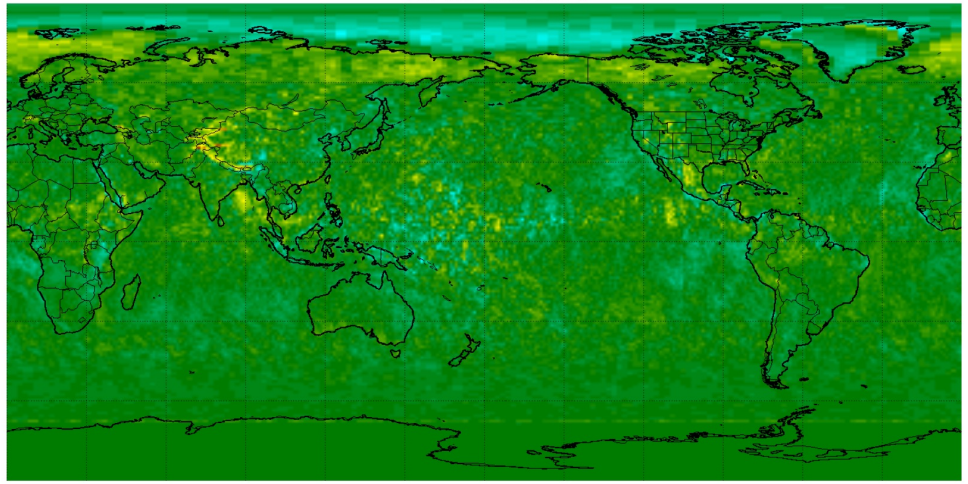
-75
-50
-25
0
25
50
75

SW TOA Flux Anomaly DIFF (Ed4.2 Minus Ed4.1)

January 2001



July 2001



(Wm^{-2})

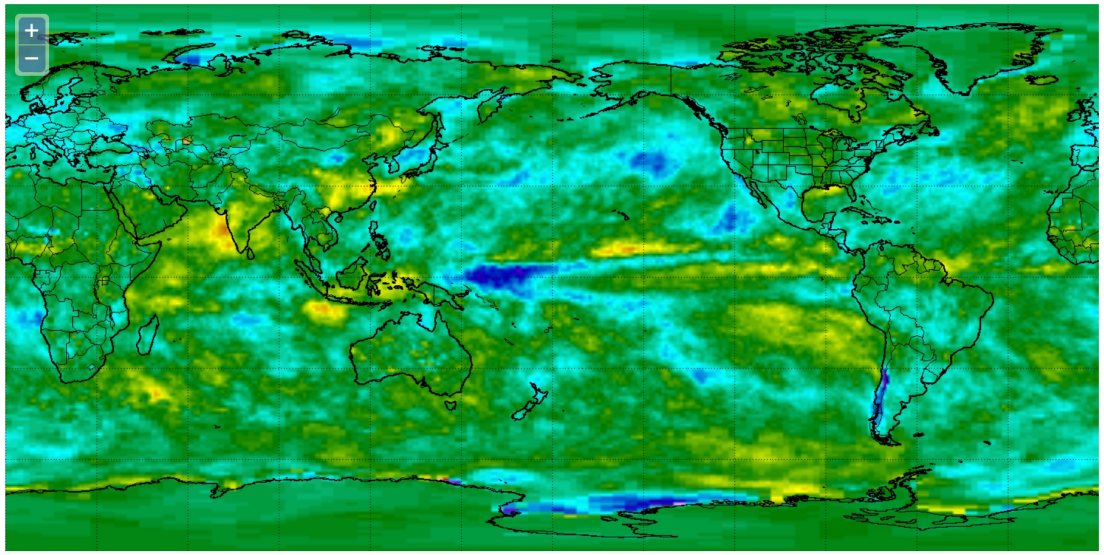
-20
-13.33
-6.67
0
6.67
13.34
20

SW TOA Flux Trend (03/2000-03/2022)

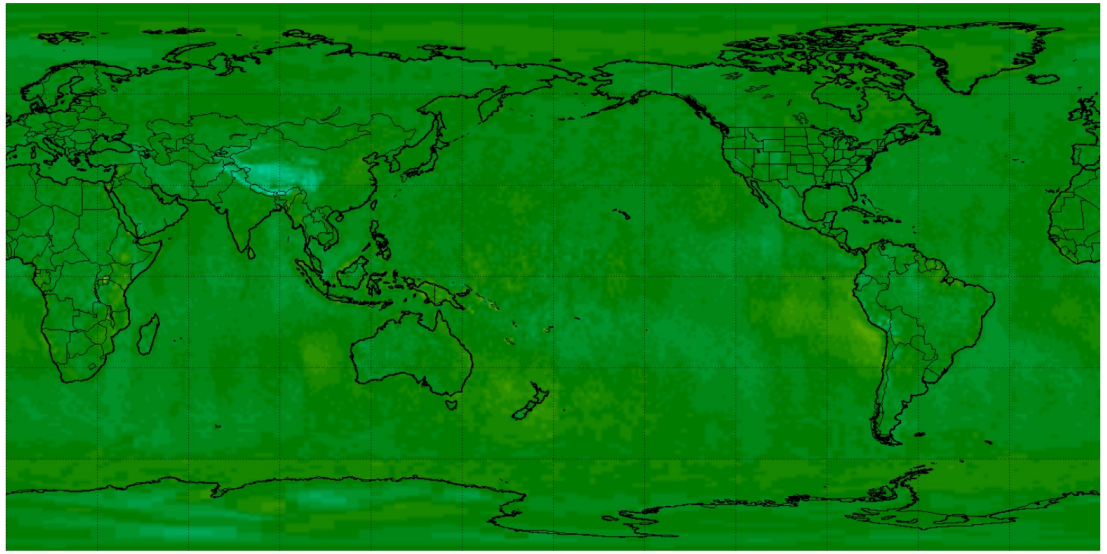
(Wm^{-2} dec^{-1})

-10
-6.67
-3.33
0
3.33
6.66
10

Ed4.2

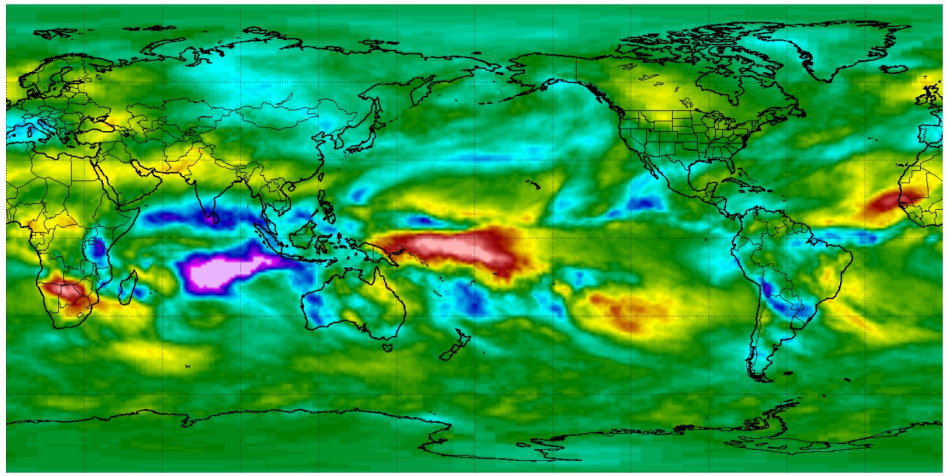


Ed4.2 minus Ed4.1

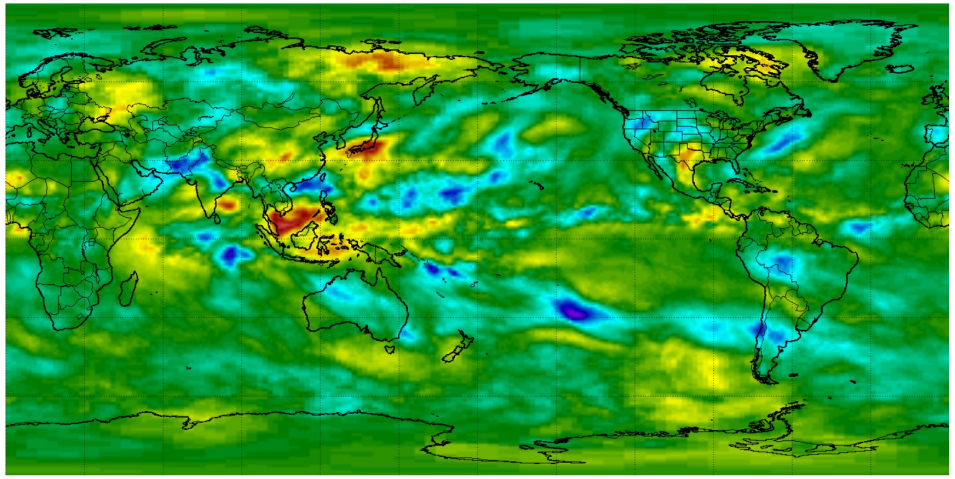


LW TOA Flux Anomaly (Ed4.2)

January 2001



July 2001



(Wm^{-2})

-42

-28

-14

0

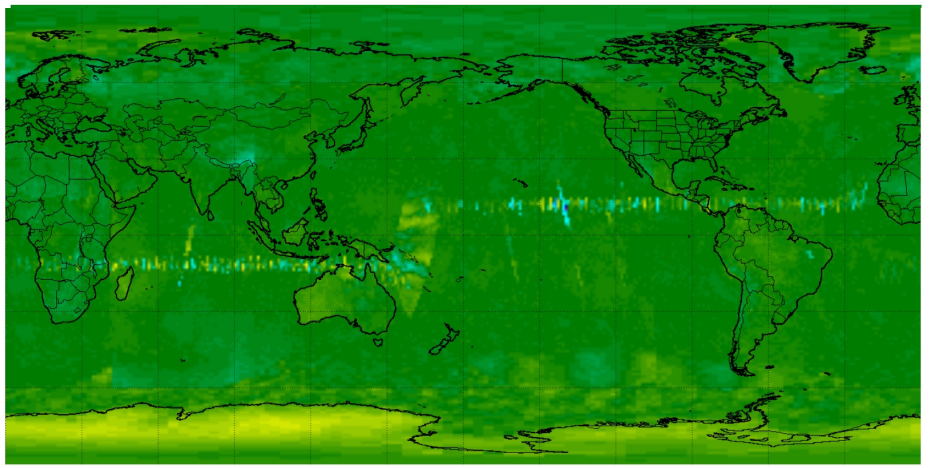
14

28

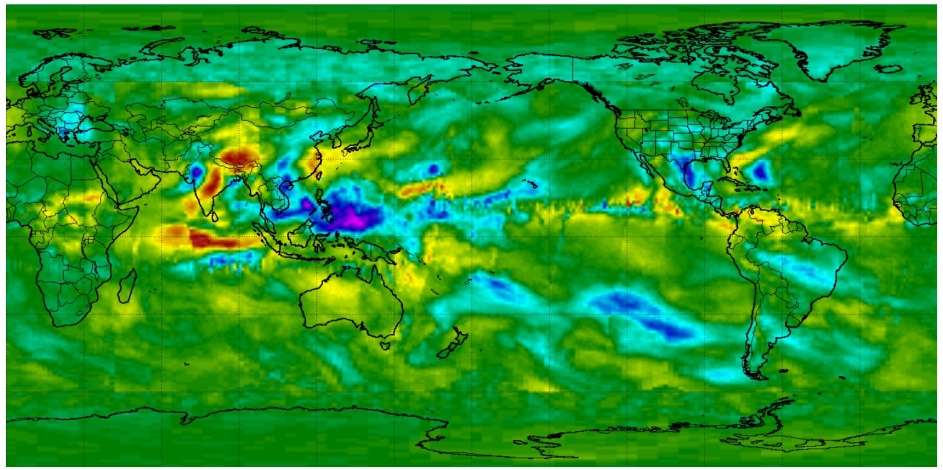
42

LW TOA Flux Anomaly DIFF (Ed4.2 Minus Ed4.1)

January 2001



July 2001



(Wm^{-2})

-10

-6.67

-3.33

0

3.33

6.66

10

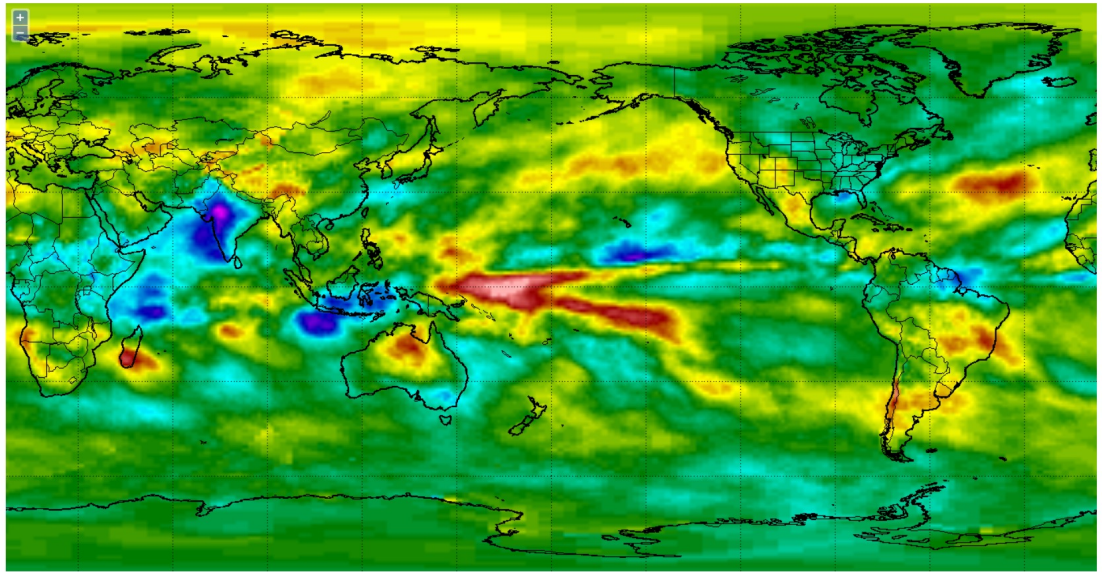
- Missing first two days of July 2001. In Ed4.1, GEO not used for days with no CERES observations. Ed4.2 uses SYN1deg GEO for days with no CERES observations.

LW TOA Flux Trend (03/2000-03/2022)

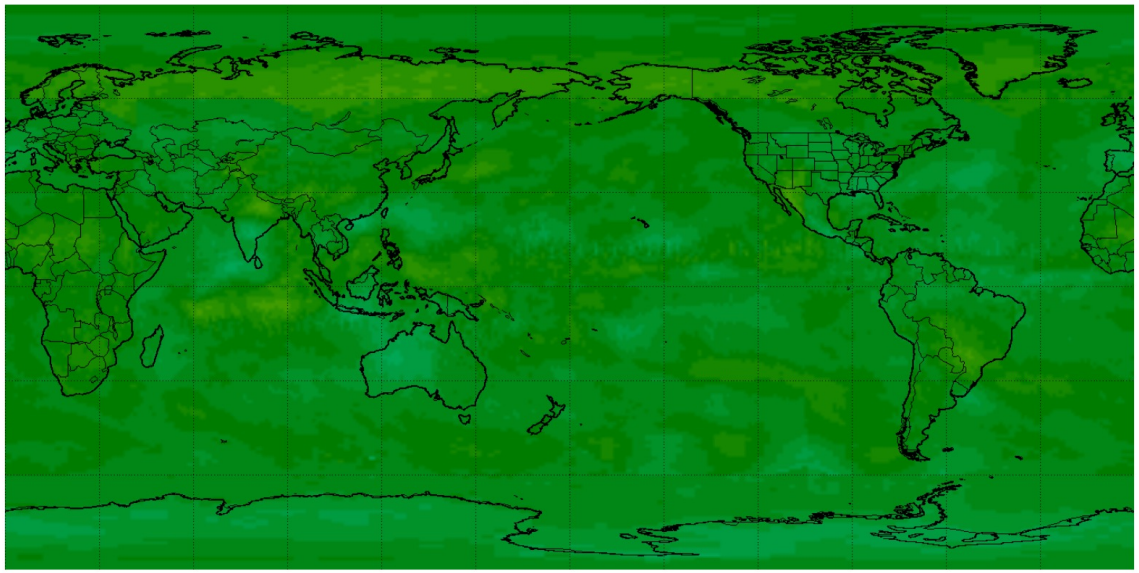
(Wm^{-2} dec^{-1})

-5
-3.33
-1.67
0
1.67
3.34
5

Ed4.2



Ed4.2 minus Ed4.1



Summary

Edition 4.2 TOA changes include:

- Transitioning from Terra+Aqua to N20-only due to TER & AQU MLT drift.
- Diurnal correction bug fix near international dateline
- Climatological adjustment of TOA fluxes during Terra-only and N20-only time period using Terra+Aqua climatology
- Compiler differences (P6 vs x86)
- Sampling: Recovery of some of the missing GEO data in Ed4.1.